Adaptive Radiations in Prehistoric Panama

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PEABODY MUSEUM OF ARCHAEOLOGY AND ETHNOLOGY
HARVARD UNIVERSITY, CAMBRIDGE, MASSACHUSETTS
1980

ISBN 0-87365-905-8

LIBRARY OF CONGRESS CATALOG CARD NUMBER 79-57108

This book was set in Palatino by the Cold Type Center, Harvard University Printing Office, and was printed and bound by the Halliday Lithograph Corporation. Manufactured in the United States of America.

8.0

Stone Tools and Their Interpretation

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8.1 INTRODUCTION

Careful analysis of lithic assemblages from tropical forest contexts has been infrequent for two very different reasons. On the one hand, the preceramic chipped stone assemblages have often been described as amorphous or as consisting of generalized cutting and scraping tools; not the sort of material that elaborate typologies and cumulative indexes are made of. On the other hand, the well-made but rather unvarying tools associated with ceramic periods are looked upon as rather insensitive indicators of archaeological cultures and chronological phases; if you've seen one celt you've seen them all.

Recent advances in technological and functional analyses of stone tool assemblages, particularly replicative experiments and wear pattern analysis, have altered this situation rather dramatically. These advances, coupled with a sharpened interest in systematics, have greatly improved our potential for recovering information about extinct cultural systems from the analysis of stone tools. This potential has yet to be fully realized. The frontiers are being pushed further and further out by lithic specialists, more rapidly than their approaches can be incorporated into the repertoire of many archaeologists. Most studies are still experimental, meant to illustrate the value of different experimental/microwear/systematic approaches (here I include the use of computer-aided statistical treatments) rather than to explain a particular body of data (e.g., Swanson 1975; Rosenthal ms. 1976; Sheets 1975).

However, in the present volume we have attempted to apply at least some of the newer approaches to the entire sample of stone artifacts recovered in the various subprojects of the western Panama project. In doing so we have tried not to neglect the obligation of any researcher to provide as complete and accurate a description of the collections as possible so that these materials can be compared with those from other archaeological sites in other regions. To do this, more less traditional artifact descriptions have been provided, as well as photographs, drawings, and tables of distributions.

In presenting the typologies for each collection, the tools were first placed into classes based on the final method of manufacture (e.g., ground and polished stone, chipped stone). They were then divided into major functional categories (e.g., celts, adzes) which in turn were subdivided into types based on formal attributes (e.g., Type A pear-shaped celts, Type B straight-sided celts). In the process of analysis, many of the tools were replicated and then used. Stereoscopic microscopes (6x-50x) were employed to examine wear patterns on both archaelogical and replicated tools. In addition, tools and flakes from archaeological and experimental collections were examined under the microscope in order to identify those attributes resulting from the manufacturing process. The reader is referred to report numbers 8, 14, 15, and 16 in this volume for detailed descriptions and analysis of collections from each of the four subareas examined in western Panama. I will, however, summarize the major features of these collections before turning to questions of tool function and the organization of tool production.

8.2 THE LITHIC COLLECTIONS

8.2.a. The Rio Chiriqui Canyon

Four rock shelters and one open campsite were tested in the canyon of the Rio Chiriqui. The bulk of the 45,000 stone specimens recovered came from preceramic occupation layers in the four shelters. A series of ten radiocarbon dates, six from Casita de Piedra and four from the Trapiche Shelter, place the preceramic occupation between 5000 and 300 B.C. (see section 3.4). Two phases were defined based on changes in the lithic assemblages. The division between the earlier Talamanca phase and the later Boquete phase falls at about 2300 B.C.

The rock shelters are all quite small, none containing more than 30 square meters of protected floor space (see report no. 1). Occupational debris did, however, extend beyond the protected space (i.e., beyond the dripline) in all cases. Ten and twelve square meters were excavated in Casita de Piedra and the Trapiche Shelter, respectively, the shelters with the deeper and more clearly stratified deposits. Five square meters were excavated at the Horacio Gonzales Site and two square meters at the Zarsiadero Shelter.

Within each phase, the tool types and chipping debris from shelter to shelter were quite similar, suggesting that all had been put to similar uses. Therefore, I will discuss the assemblages by phase, drawing primarily on data from Casita de Piedra and the Trapiche Shelter, where stratigraphic separation of the phases was quite clear.

Most of the tools of the Talamanca phase were made of chipped stone, or were used in the making of chipped stone tools (hammers and anvils). The chipped stone technology represented was quite simple: direct percussion using a hammerstone, and occasionally an anvil stone, was probably the only knapping method employed. Platform preparation was minimal to nonexistent. Large blocks of andesite, the most common raw material found during the Talamanca phase (over 90 percent of all flakes and tools), were normally reduced by detaching flakes from any convenient platform. Thus most andesite cores are irregular. There are, nonetheless, a few conical cores and bifacial cores in the collections. Smaller chunks of material, most often chalcedony and quartz, were reduced using the bipolar flaking technique. In this method, the core is placed on an anvil stone and a hammer is swung directly onto the top of the core. Although a rather crude technique, it does facilitate the fracturing of small pebbles.

Used flakes of various shapes and sizes were the most commonly encountered tools. These flakes, modified only through use, were employed in cutting, engraving, scraping, planing, and chopping. Unifacial retouch was used to manufacture scraper-planes, some steep scrapers and some gravers. Bifacial retouch was used primarily for the manufacture of large celtlike wedges. A few choppers exhibit bifacial retouch as well. The only other technique employed was the detachment of a burin spall to make rather delicate burins.

In addition to these chipped stone tools, hammers, and anvils, the Talamanca phase deposits contained tools made on unmodified cobbles and boulders. The most distinctive tools are edge-ground cobbles, generally flat and somewhat oval in outline with a facet worn along the narrow edge. These cobbles were presumably used against milling stone bases, also recovered from Talamanca deposits, for mashing and grinding. The flat to slightly convex facet on the edge-ground cobbles and the flat to slightly concave face of the milling stones were produced by the action of one upon the other. A less common artifact is the nutting stone, so called because it appears to have been used for cracking the hard nut or kernel of the corozo palm. Similar stones are still used in Panama for this purpose. They are simply cobbles in which a small depression has been made.

The chipped stone assemblage of the Boquete phase (2300–300 B.C.), also preceramic, is in most respects similar to that of the Talamanca phase. Both phases share most of the same tool types. However, bipolar flaking does become more common in the Boquete phase because of the increased use of chalcedony, quartz, and obsidian, materials normally available only as small pebbles or nodules. During this phase bifacial wedges cease being made; instead, small tabular wedges or chisels *(pièces ècaillées)* are found in quantities reaching 50 percent of the tools recovered in some layers. Quartz crystals are also used as wedges or chisels during the Boquete phase.

Edge-ground cobbles and milling stone bases continue to be found in Boquete phase deposits. Nutting stones occur as well. In addition, a few handstones are found whose working facets are on the flat face of the cobble or offset toward one edge. Small pestles also occur for the first time during the Boquete phase.

Both the cobble tools and the chipped stone tools from the two preceramic phases are quite simple to make. In fact, in the majority of cases the "making" consists of selecting a flake or cobble with the proper shape and size. However, a few ground and polished stone tools — celts, chisels, and axes — were also found in Boquete phase contexts. These are, of course, quite sophisticated tools, demanding skills in bifacial flaking for preforming the tools as well as skills in pecking, grinding, and polishing. The amount of time necessary to complete one of these ground and polished stone tools far exceeds the time needed to make the other tools found in the preceramic phases. More will be said about ground and polished tools in the context of later ceramic phases where they become increasingly important. It is, nonetheless, important to remember that the tools first appear in preceramic contexts.

The Rio Chiriqui shelters ceased being intensively used after the introduction of ceramics into western Panama at about 300 B.C. Better evidence for the use of stone during the post-300 B.C. ceramic period is provided by stone assemblages from the highland region of Volcan, from the Aguacate Peninsula along the Caribbean coast, and from Isla Palenque along the Pacific coast (see report nos. 14, 15, and 16). The sites examined in the Volcan region are dated earlier than those along either coast, and in some sense seem ancestral to them (see section 7.9). For this reason I will discuss the Volcan site first, then the site of La Pitahaya on the Pacific coast, and finally the sites on the Aguacate Peninsula.

8.2.b. The Volcan Highlands

In the Volcan region, one site, Pitti-Gonzalez (BU-17), was extensively excavated and two others, Barriles (BU-24) and Fistonich (BU-22), were tested. An additional 42 sites were located in an intensive survey of the region (see report nos. 2–5). Stone tools were collected from the surface of these sites as well as from the excavations. A large series of radiocarbon dates from Sitio Pitti-Gonzalez and Barriles fix the main occupation of these sites between A.D. 200 and A.D. 600 (see section 7.4.c.). Cross-dating of the surface pottery collections with those from the excavated sites suggests that with a few possible exceptions, all sites located in the survey fall within this same time span. Slight differences in the ceramic collections enable two main ceramic phases (Early Bugaba and Late Bugaba) to be distinguished, each lasting approximately 200 years. No such distinctions could be made based on the much smaller lithic collections (see report no. 14, tables 1–3). This is not to say that distinctions between lithic assemblages from these two phases do not exist, only that much more extensive collections are needed in order to determine whether or not such distinctions exist. In any event, the collections for all of the Volcan sites will be grouped together for consideration. There are nearly 300 tools and 3,000 flakes in the combined collection.

The chipped stone industry of the Volcan sites has been aptly characterized by Sheets (1975) as a cottage industry. Flakes were struck from unprepared cores with hammerstones and used with little or no modification. Some scraper-planes, scrapers, and perforators were formed by simple unifacial retouch. Other scraper-planes and scrapers were not retouched before use, as was the case with knives and choppers. These flake tools and the cores from which they were struck were widely distributed, being found in the smallest as well as the largest habitation sites.

A variety of tools recovered from the Volcan sites were used in grinding, mashing, and pounding activities. Most common among these were metates, both legged and slab varieties, and cylindrical manos. These tools were almost certainly used to grind maize. Also numerous were milling stones, made of suitably shaped but unmodified boulders, and the oval and spherical handstones that were presumably used with them. Large stone mortars, some formed in bedrock and others in boulders, were also present. Several small slabs ("palettes") with smoothed surfaces were apparently used for grinding or pulverizing small amounts of materials, perhaps pigments.

Ground and polished stone tools were recovered from a number of sites in the Volcan region. With few exceptions, all such tools were celts that can be placed in two categories. Type A or pear-shaped celts have a bit which extends in an unbroken curve back along both sides of the implement. Type B celts have straight sides which taper slightly from the bit to the butt end. A single small celt (Type C) had incurvate sides. One chisel was also recovered from Sitio Pitti-Gonzalez. The skills required to manufacture these ground and polished stone tools and the time invested in their production suggest that this activity was in the hands of specialists.

8.2.c. La Pitahaya in the Gulf of Chiriqui

Test excavations were carried out in several parts of the large site La Pitahaya (IS-3), located on Palenque Peninsula just off the mainland of Chiriqui. The excavations produced approximately 1,000 stone tools and an additional 1,000 flakes. Shared ceramic similarities between the bottom of La Pitahaya deposits and the upper layers of Sitio Pitti-Gonzalez place the beginnings of the IS-3 occupation at A.D. 600, if not earlier (see section 7.7). The earliest phase at La Pitahaya, the Burica phase (Linares 1968b), was contemporary with the Late Bugaba phase in the highlands. The middle layers of the site are dated to A.D. 700–900 and attributed to the San Lorenzo phase. The Chiriqui phase is represented by materials in the top layers of the site which date to A.D. 1000–1100 (section 7.8). Although there are some differences in the frequencies of stone tool types for these three phases, the types themselves continue to be found throughout the deposits. Here I will summarize the assemblages of the site as a whole, and save discussion of the changing frequencies of tool types until later.

The ground and polished stone tool industry at La Pitahaya is very much like that described for the Volcan sites even though the collection is considerably larger (199 vs. 40 specimens). Pear-shaped Type A celts and straight-sided Type B celts were the most common tools encountered. A smaller celt type ("C") is thinner in cross section than other celts. A small number of adzes and chisels was also recovered. These ground and polished stone tools had invariably been broken and/or reused as hammerstones.

Like the Volcan sites, metates and cylindrical or bar manos were the principal grinding tools at La Pitahaya. A number of ovoid manos occurred at the site as well. Milling stones, while present, were rare. Nutting stones were very common tools (38 specimens) as were large and battered pounding-mashing stones (pestles). Three tool types were unique to La Pitahaya and seem to reflect its coastal location. Notched and grooved pebbles, thought to have been used as net weights and line weights, were found in considerable numbers. Several rasps or sandstone saws were also present. These thin flat pieces of sandstone have sharp beveled edges and are thought to have been used for working shell.

The chipped stone industry has two very different aspects. There was at La Pitahaya a household industry where flakes were detached from unprepared cores and used without further modification for cutting, scraping, and perforating. Small nodules were reduced by the bipolar flaking technique; both bipolar cores and anvils were recovered from the site. Shelton Einhaus (report no. 15) has suggested that some of the small quartz chips produced by bipolar flaking may have been grater chips, or teeth set in wooden graterboards. Used flakes and possibly these grater teeth were the only products of this household industry. Purposeful retouch was very rare if not completely absent.

In contrast, there are two artifact types, blades (and tools made on blades) and trifacial points, that are clearly the product of a sophisticated technology. The long straight blades were detached from prepared cores with considerable skill. The trifacial points are triangular in cross section, flaked across all three surfaces and tanged. Both tool types were most certainly the products of specialists.

8.2.d. The Aguacate Peninsula, Bocas del Toro

Major excavations were conducted at the dispersed hamlet of Cerro Brujo (CA-3) on the Aguacate Peninsula. Test excavations were also undertaken at the neighboring Sitio Machuca (CA-2). Two components were recognized at the CA-3 locality. The major occupation occurred in what is called the Bocas phase and is dated by several radiocarbon determinations to A.D. 900. An earlier occupation is dated by ceramic cross-dating with highland Volcan sites to A.D. 600–700 (section 7.6). Little of the initial or Aguacate phase occupation was excavated at Cerro Brujo, and an Aguacate phase at CA-2 was absent altogether. Only six tools (two Type A celts, three Type B celts, and one chisel) and nine flakes were recovered from Aguacate phase contexts. Therefore, my discussion will be restricted to the 145 tools and 112 flakes recovered from Bocas phase contexts.

Ground and polished stone tools were the most common artifacts recovered in the Aguacate Peninsula sites. The straight-sided Type B celts and pear-shaped Type A celts were the dominant forms (50 and 18 specimens, respectively). Small celts with incurvate sides (Type C) were also present. In addition to these celts, one axe and a number of chisels and adzes were found. Like La Pitahaya, most of the ground and polished tools were broken and/or recycled as hammerstones.

Unlike all previous areas discussed, tools for grinding and mashing are either rare or absent. Only two possible handstones and two pestles were recovered in the excavations. Similarly, only four tools can be considered as products of a household chipping industry (along with five cores and twelve flakes). Most of the chipped stone tools at Cerro Brujo and Sitio Machuca are made on blades. Tangs were flaked on a number of these blades to faciliate hafting. Some blades were used as struck, others were modified by unifacial or bifacial retouch. Still others had narrow, chisellike bits produced by grinding and polishing. Blades were used for slicing, scraping, sawing, perforating, drilling, whittling, and chiseling (see report no. 16).

8.3 TOOL FUNCTION AND SITE ACTIVITIES

In the discussions above I purposely concentrated on describing the technology of tool production because it is the least speculative aspect of lithic analysis. It is somewhat more difficult to determine the nature of the material on which the tool was employed. One can, for example, be more confident in identifying a tool as a scraper than identifying it as a *hide* scraper. Nonetheless, experiments to replicate tool functions and microwear analysis, particularly under high magnification, have proved to be surprisingly accurate in a controlled test situation (see Keeley and Newcomer 1977).

In our analysis of the western Panama tool assemblages, we conducted a number of experiments with replicated tools in order to study tool function. A stereoscopic microscopic (6x-50x) was used to examine tools and flakes for evidence of wear. The functional interpretations based on the tool use experiments and on the microwear analysis are discussed in report numbers 8, 14, 15, and 16 (see also Ranere 1975) in some detail. Certain implications of these studies are presented below.

While interpretation of function is a more hazardous undertaking than the interpretation of technology, it often provides information on site activities available from no other source. This is particularly true in the humid tropics where preservation of archaeological materials is generally poor. For example, we are almost entirely dependent on functional interpretations of stone tools for information on activities carried out during the preceramic occupation of the Rio Chiriqui shelters.

Three general kinds of activities are indicated by the stone tools for both the Talamanca and Boquete phases in the Rio Chiriqui canyon: stone working, woodworking, and plant processing. Hammerstones and anvils were the only tools recovered that were used for making stone tools, and most likely they were the only ones used at the shelters. They were, at any rate, the only tools I needed in order to replicate the range of stone tools found at the sites (ground and polished tools excepted). The 45,000 flakes and cores recovered from the shelter deposits clearly document the importance of stone tool manufacturing at the sites.

Most of the chipped stone tools from the Rio Chiriqui shelters appear to have been used in working wood. Included here are bifacial wedges, tabular wedges, broad-based wedges, scraper-planes, choppers, burins, gravers, spokeshaves, used quartz crystals, and at least some steep scrapers, flake scrapers, and flake knives. Not all tools in these categories had identifiable use wear. Some were either not used, or not used enough for wear to be discernable under the magnification we employed in our analysis. Moreover, the surfaces and edges of a number of andesite tools were so altered by weathering that only the largest use flakes could be recognized. Nonetheless, a number of tools in each category had seen heavy use, and the resultant wear was visible under the microscope. In addition, the wear patterns were duplicated on replicated tools in laboratory experiments where wood was chopped, split, planed, chiseled, scraped, engraved, and whittled (report no. 8 and Ranere 1975). The emphasis on woodworking at the sites seems reasonable, both in the light of the emphasis placed on it by later tropical forest peoples and in light of the similarly interpreted contemporary assemblages in other parts of the tropics (section 3.8.c.).

More difficult to interpret are the edge-ground cobbles and milling stone bases, the principal plant processing tools in both Talamanca and Boquete phases. The use facets along the narrow edges of the edge-ground cobbles are very pronounced, but in all of the Rio Chiriqui specimens, the cobble surfaces were too heavily weathered for the preservation of any microwear attributes. However, well-preserved edge-ground cobbles have been recovered from the Aguadulce Shelter and Monagrillo site in central Panama (Ranere and Hansell 1978). These cobbles often have use flakes driven off the edges of the working facet. Many have one longitudinal edge of the facet more rounded than the other as if the tool was slightly rolled while in contact with the milling stone base. In addition, striations perpendicular to the long axis of the facet can be seen on some specimens. These wear patterns suggest that the tools were used against milling stones in a motion combining pounding and grinding, wherein the cobble was struck against the milling stone and then drawn toward the user. In laboratory experiments, unmodified cobbles and flat boulders were used in this manner to mash a variety of tubers, including manioc. The tools seemed quite efficient, particularly if the tubers were first cut into sections. Wear patterns identical to those on the archaeological specimens from central Panama were produced experimentally (Moser ms.1977).

It is one thing to show that manioc and other tubers *could* have been mashed by edge-ground cobbles and quite another to show that manioc and other tubers *were* mashed by edge-ground cobbles in the Rio Chiriqui shelters. Still, our experiments indicated that these narrow-faceted tools were much less efficient at grinding maize than were broad-faceted manos (just as one might expect); yet they were more efficient than manos for mashing starchy tubers. Edge-ground cobbles and milling stone bases are common tools in the Rio Chiriqui sites and were presumably used in the every day activity of food preparation. The most obvious choice of food in a tropical forest environment is starchy tubers, among which manioc was the most important historically; the question whether these tubers were wild or domesticated also remains to be answered.

Interpreting tool function during the later ceramic phases is less problematic because of the continuity with the historic period and because plant and animal remains from the excavations provide corroborative evidence. The identification of the archaeologically recovered manos and metates as maize-grinding implements is supported by the historic and modern use of nearly identical objects in Panama and elsewhere in tropical America. Moreover, carbonized maize remains and maize pollen were recovered from both Sitio Pitti-Gonzalez and La Pitahaya. Wear pattern analysis and experimental use of manos and metates to grind maize, though consistent with this identification, seem somehow superfluous. The association of manos and metates with maize is so well documented, in fact, that their absence from the Aguacate Peninsula sites assumes considerable significance. One is almost forced to conclude that maize was not used as a staple at these sites, in marked contrast to those sites on the Pacific side of the continental divide.

The use of ground and polished stone celts and axes for woodworking and particularly for felling trees is well documented historically. Given the botanical evidence for agriculture at the Volcan sites and at La Pitahaya, little doubt remains that these tools were used in felling the vegetation prior to planting. The celts at Cerro Brujo were almost certainly also used in clearing the forest to make agricultural fields as well, although maize was probably not a major crop. Even though carbonized remains of domesticated plants were not recovered at Cerro Brujo, the presence of large numbers of celts provides good indirect evidence for cultivation at the site.

Woodworking other than tree felling continued to be an important activity during the ceramic period, just as it had been previously. Ground and polished stone chisels and adzes replaced a number of chipped stone tool types, but some chipped stone woodworking tools were still used (whittling knives, scrapers, and spokeshaves).

Hammerstones are found in all the assemblages dating from the ceramic period, but are particularly numerous at La Pitahaya and Cerro Brujo. In both sites, damaged and broken celts (and most of the recovered celts fit this category) almost invariably were reused as hammers. Pounding facets are generally quite broad, and we are probably safe in calling these implements pecking hammers. There was not enough chipping debris at either site to support the contention that they were knapping hammers (the ratio of flakes to hammers at Cerro Brujo is about 2 to 1!). These pecking hammers appear to have been used primarily to reshape damaged and dulled celts and other ground and polished stone tools. Whetstones and pebble polishers, found in Volcan, Aguacate, and La Pitahaya sites, were also used for reshaping and sharpening ground and polished stone tools (see discussion below).

Other implements whose function seems reasonably clear include the notched and grooved stones found in large numbers at La Pitahaya. One notched stone was found at Sitio Machuca on the Atlantic as well. These stones have been identified as net weights and line weights used in fishing. Both net fishing and line fishing are implied by the species of fish recovered from La Pitahaya deposits (see section 13.0). No such weights were found at Cerro Brujo, however, possibly because nets are difficult to use over coral reefs (section 13.3).

"Nutting stones" appear to be accurately named. Similar stones are still used in Panama to crack the hard shell of the corozo palm nut while leaving the nut meat in one retrievable piece (without the depression in the nutting stone the nut meat is sometimes smashed into bits). These tools were found in the Rio Chiriqui shelters, Sitio Pitti-Gonzalez, and La Pitahaya, as were carbonized remains of the corozo palm nut (see section 10.6).

A number of other tools made of cobbles and boulders present at the Volcan sites and in La Pitahaya can be loosely described as plant-processing tools. These include milling stones, mortars, pestles or pounding-mashing stones, and handstones of various kinds. These implements were probably used to process foods other than maize since manos and metates were available for that purpose. It is interesting to note that at La Pitahaya, these "non-maize" food-processing tools (including nutting stones) are much more common in the latest Chiriqui phase than they are earlier, while the number of metates increases only slightly. Shelton Einhaus (report no. 15) speculates that this may reflect increased reliance on foods other than maize, particularly tree crops and root crops that allow the land to stay in production longer. Such a shift in food production may have represented an attempt to feed a growing population, or an attempt to adjust to tropical soils impoverished from too many years in maize production.

Shelton Einhaus has further suggested that a number of small quartz flakes from La Pitahaya might well have been insets for graterboards. Such graterboards were widespread historically in South America east of the Andes and in the Caribbean. They were (and still are) used for shredding bitter manioc so that the poisonous juices could be squeezed out. Graterboard teeth were not necessarily made of stone, but this was often the case (cf. Lathrap 1973). The specimens from La Pitahaya are only slightly larger than some ethnographic samples reported by DeBoer (1975). Of course, the La Pitahaya specimens may not be grater teeth at all, or they may be grater teeth and the grater may have been used for grating something other than manioc. Notwithstanding, manioc pollen was recovered in sediments near La Pitahaya which were contemporary with the occupation (report no. 17). If edge-ground cobbles and milling stone bases are an earlier (and perhaps less efficient) alternative to graterboards for reducing manioc to a pulpy mass, as I suspect, then the presence of grater chips at La Pitahaya but not edge-ground cobbles and the presence in the Rio Chiriqui shelters of edge-ground cobbles but not grater chips makes a good deal of sense.

8.4 THE ORGANIZATION OF STONE TOOL PRODUCTION: EVIDENCE AND IMPLICATIONS

The one aspect of lithic analysis that inspires most confidence is the technology involved in the production of stone tools. The tools themselves are available for analysis, waste flakes and workshop rejects or mistakes representing different stages in the manufacturing process can often be examined, and many of the tools used to make stone tools are recoverable. Moreover, experimental replication of stone tools has a long history, and has witnessed an impressive resurgence of interest during the past decade (see Johnson 1978 for a recent assessment). Hence, it is not by accident that my summaries of the lithic assemblages from western Panama focused on the technology. Because the stone technology from this area is reasonably well understood, it seems worthwhile to examine it more closely for the information it can provide on craft specialization and intersite contact.

In this section I would like to examine the proposition that within a 3,000 year period populations living in self-sufficient communities in western Panama were transformed into populations whose communities were integrated at the regional level. I will limit my discussion for the most part to evidence provided by the changing technology of stone tool production. The Talamanca phase (5000–2300 B.C.) and the Bocas phase (A.D. 900) represent the beginning and end points of this organizational transformation. During the Talamanca phase social groups appear to be completely autonomous and independent with respect to stone tool production; on the other hand, the Cerro Brujo residents appear almost completely dependent on outside specialists for tool production. Although there is little common ground for making a technological comparison between Talamanca and Bocas phase assemblages, the assemblages from the Boquete, Bugaba, Burica, and San Lorenzo phases bridge the gap nicely.

8.4.a. Stone Tool Production During the Preceramic Period

A number of lines of evidence indicate that during the Talamanca phase occupation of the Rio Chiriqui canyon, all of the tools made in the shelters were also used in the shelters, and all the tools used in the shelters were made in the shelters. That is to say, the shelter inhabitants were neither producing tools for use elsewhere, nor were they importing tools for use at the shelters. It is important, I think, to establish the facts that (1) these Talamanca groups were self-sufficient at least insofar as the production of stone tools is concerned, and (2) the skills to produce *all* of the Talamanca tools were widely distributed in the population (i.e., none was the product of specialists).

That tool production was an important activity in the Rio Chiriqui sites should be evident from the quantities of waste flakes recovered (nearly 45,000 in 31 cubic meters excavated). The materials used for making stone tools were readily available to the canyon occupants, and they appear to have brought blocks, cobbles, and pebbles of these materials back to the shelters to make their tools. Flakes with cortex on their dorsal surfaces were quite common in the collections and several cobbles and pebbles of andesite, chalcedony, quartz, and obsidian were recovered that had been carried into the shelters but never used.

A rough index of the amount of chipped stone tool manufacturing carried out at an archaeological site can be arrived at by looking at the ratio of flakes to finished tools. In a lithic workshop site where most of the finished tools are exported, the ratio should be quite high. At the other extreme, at sites where tools are imported in finished form, the ratio should be quite low. Table 1 lists the ratios of flakes to chipped stone tools for the most extensively excavated sites in western Panama by phase. The ratios listed in the table indicate very clearly that a lot of stone tool manufacturing was going on during the Talamanca and Boquete phases in the two Rio Chiriqui shelters and during the Bugaba phase at Sitio Pitti-Gonzalez. The ratios also indicate that very little manufacturing was going on at La Pitahaya and Cerro Brujo.

I have already noted that the technology for the Talamanca phase was relatively simple. Not only was there very little skill involved in making many of these tools, but they could be made in a matter of seconds. The only exceptions were bifacially flaked celtlike wedges which demand a moderate amount of skill to make. Still, judging from my replicative efforts, it probably took less than ten minutes to make a bifacial wedge.

Despite the greater skill needed to produce them than to produce any of the other tools, bifacial wedges appear to have been manufactured at all the Rio Chiriqui sites containing Talamanca phase deposits. There are simply too many flakes in the collections that were clearly struck from bifaces (i.e., flakes which retain part of the biface edge and opposite face on their platform) to assume they all came instead from the few bifacial cores and choppers present. In a sample of 1,070 flakes from an excavation unit in

TABLE 1 THE RATIO OF WASTE FLAKES TO CHIPPED STONE TOOLS FOR THE PRINCIPAL SITES EXCAVATED IN WESTERN PANAMA*

Phase	*Site*	*Flakes*	*Tools*	*Ratio*
Talamanca (4600–2300 B.C.)	Casita de Piedra	15,488	368	42.1:1
Talamanca	Trapiche Shelter	13,340	282	47.3:1
Boquete (2300–300 B.C.)	Casita de Piedra	8,685	561	15.5:1
Boquete	Trapiche Shelter	3,095	108	28.7:1
Bugaba (A.D. 200–600)	Sitio Pitti-Gonzalez	2,051	104	19.7:1
Burica (A.D. 600–700)	La Pitahaya	311	65	4.8:1
San Lorenzo (A.D. 700–900)	La Pitahaya	273	72	3.8:1
Chiriqui (A.D. 1000–1100)	La Pitahaya	201	73	2.8:1
Bocas	Cerro Brujo	22	28	0.8:1

*Celt flakes are excluded from the flake count; cores are included in the tool count.

Casita de Piedra, 24 or 2.2 percent were struck from bifaces. I should point out that most flakes removed in the manufacture of bifacial wedges cannot be identified as such. In analyzing the chipping waste from one experimentally manufactured bifacial wedge, I was able to classify only 10 of 205 flakes (larger than 1/4 inch) or about 5 percent as unmistakable products of bifacial reduction. If this result is at all applicable to chipping waste from prehistorically produced bifacial wedges, then about 44 percent, not 2.2 percent of the waste flakes from Talamanca deposits were the product of bifacial flaking. This amounts to some 6,000 flakes or 125 flakes for every bifacial tool and tool fragment recovered in Casita de Piedra (the ratio is about 100 to 1 at the Trapiche Shelter). This ratio is not terribly different from the 187 to 1 ratio of flakes to bifacial wedges for tools I have made experimentally (n=5). If bifacial fragments from Casita de Piedra are counted as half of a finished tool, then the Talamanca flake to tool ratio is 167:1, very close to the experimental value. But this is dangerously close to playing with numbers (if fragments are counted as one-third of a finished tool, the experimental and archaeological ratios are closer still!), and I need not belabor the point further. Bifacial wedges were almost certainly manufactured at all the Talamanca phase sites, and therefore the skills necessary to make *all* the tools from Talamanca assemblages are judged to have been widely distributed in the population.

The idea that the Rio Chiriqui sites were not *just* workshops, however, is supported by two lines of evidence. First, few of the unused, unfinished (blanks and preforms) or rejected tools normally encountered in a lithic workshop are present in the shelters. Second, a large number of tools show evidence of use (see discussion above). Bifacial wedges, for example, exhibit use polish and striations on their bits and on high spots back along both faces. The butt ends have also been heavily battered. Moreover, a number of resharpening flakes retaining the worn bit edge of the wedges were also recovered. This suggests that the wedges were resharpened perhaps several times before being discarded. The existence in the collections of wedges that were abandoned after unsuccessful attempts at resharpening, and short wedges that were reused as hammers, provides further evidence that these tools were heavily used.

Tools made on unmodified flakes and cobbles can only be identified as tools because they show use wear. Hammerstones, anvils, edge-ground cobbles, milling stones, cobble spall choppers, flake choppers, flake scrapers, and flake knives all fit into this category. Wear polish, striations and/or use flakes were also observed on scraper-planes, steep scrapers, concave scrapers, gravers, and burins (Ranere 1975).

As a final check on the production versus the use of tools during the Talamanca phase, I determined the ratio of waste flakes (over 1/4 inch) to cores and core tools for the Trapiche Shelter and Casita de Piedra. I included bifacial wedges, irregular bifacial wedges, bifacial fragments, bifacial choppers, scraper-planes, conical cores, bifacial cores, and irregular cores but not small bipolar cores in the count of cores and core tools. The ratios for Casita de Piedra and the Trapiche Shelter were 171:1 and 145:1, respectively. These ratios are very close to the 187:1 ratio produced in the experimental manufacture of bifacial wedges. Thus, all lines of evidence support the proposition that the tools made at the sites were used at the sites and vice versa.

I would be remiss if I did not note that a single large fragment of a stone bowl was recovered from Talamanca phase deposits in Casita de Piedra (see report no. 8). The fragment represents the only artifact that may well have been imported into the site, and the only artifact that was probably the product of a specialist.

A very similar picture of tool production and tool use can be seen for Boquete phase deposits. If anything, the chipped stone technology was even simpler since bifacial wedges were no longer made (there is a corresponding drop in flakes produced in bifacial reduction). A few scraper-planes, bifacial choppers, and scrapers were made by secondary retouch, but most tools were simply appropriately shaped flakes or cobbles modified through use. The dominant tools — small tabular wedges or chisels — are easily made by bipolar flaking. The ratio of flakes to tools (about 15 to 1; see table 1) in the Boquete deposits lends support to the proposition that the tools used at the sites were also made there.

A half dozen of the 800 artifacts from Boquete phase contexts do not conform to the pattern described above. These include five ground and polished stone tools, among them a grooved axe, a celt, and a chisel, as well as an incised rim sherd from a stone vessel and a cup-shaped stone mortar (figs. 3.0-4 and 8/9). In spite of their small numbers, the ground and polished tools are important in that they signify the introduction of a new technology for stone tool manufacturing, requiring skills in bifacial flaking for preforming the tools, as well as skills in the pecking, grinding, and polishing needed to complete them. Each tool, in addition, represents a considerable investment in time, one measured in hours, not minutes or seconds as is the case with other Boquete tools.

These ground and polished stone tools may have been made at the shelters. Tools that I have described as "pestles" are limited in the Rio Chiriqui sequence to the Boquete phase and may, in fact, have been pecking hammers. However, no other implements associated with the production of ground and polished stone tools, e.g., whetstones and pebble polishers, were recovered. Therefore, it seems more likely that the tools were made elsewhere and imported into the Rio Chiriqui sites. This is probably true of the stone bowl and cup-shaped mortar as well. (More will be said about the production of ground and polished stone tools in the context of later ceramic phases where they become more common.)

8.4.b. Craft Specialization and Regional Interaction During the Ceramic Period

The character of the lithic assemblages from western Panama changes rather dramatically after 300 B.C., or at the time when pottery is added to the cultural inventory. Stone celts become common tools in the assemblages from highland Volcan sites. These same assemblages also contain large numbers of manos and metates, the latter often quite elaborate. Both the ground and polished stone tool industry and the mano and metate industry point to the existence of well-established craft specialization. This specialization is documented in a spectacular fashion by the large stone sculptures known chiefly from Barriles, which include life-sized human figures, the enigmatic stone "barrels" which gave the site its name, and enormous (over six feet in length) legged tables or metates (Stirling 1950; Linares et al. 1975).

Existing alongside these specialized crafts was a chipped stone tool industry consisting of little more than the production of flakes from unprepared cores. These flakes were then simply used as detached, or on rare occasion modified by light unifacial retouch. At Sitio Pitti-Gonzalez, the ratio of flakes to tools is high, indicating that these chipped stone tools were made on the spot. The household nature of this industry is also confirmed by the widespread occurrence of cores and flakes in surface collections from both large and small sites in the survey area.

One chipped stone artifact type, dacite laterally flaked slabs, deviates from this pattern by being restricted in distribution to a few larger sites and by requiring more skill and time in its manufacture.

Thus, during the Bugaba phase (A.D. 200–600), the production of a number of tools, like knives, scrapers, and milling stones, was still in the hands of the household, or at least of the local community. The production of other tools, like celts and metates, was clearly in the hands of specialists, however. Celts and metates are essential components of any household inventory of subsistence farmers, just as essential certainly as chipped stone knives, scrapers, and milling stones. It is of some importance, I think, to know where these tools were produced and how they were distributed. An examination of the evidence (or lack of evidence) for celt and metate production leads me to suggest that (1) only a few of the largest sites in the region were involved in the production, maintenance, and distribution of the tools, and (2) the major production center(s) for ground and polished stone tools, and perhaps for metates and manos as well, lay outside the surveyed zone.

Because the materials used to manufacture celts and other ground and polished stone tools differed with few exceptions from those used to make other stone tools, waste flakes from celt preforming and celt resharpening can be distinguished from other chipping debris (report no. 14). In the case of celt resharpening or reshaping by percussion flaking, a portion of the polished or ground surface is often retained on the detached flakes. Celts that have been reused as cores also produce flakes with ground or polished facets (a few were also undoubtedly produced in accidental damage to the celts). These "celt flakes" are clearly not the result of initial celt production, but rather indicate celt reshaping or celt recycling. Of course, not all flakes removed in celt reshaping or recycling will retain remnants of the tool surface. In one resharpening experiment which I conducted, 14 out of the 48 flakes detached (over 1/4 inch) or 29 percent showed no evidence of having been removed from a celt, and, if found in archaeological contexts, could not be classified as celt flakes.

Celt flakes were recovered from only nine of the 45 sites recorded in the Volcan region, including the three sites where excavations were conducted. Only six sites yielded flakes of celtlike materials (possible celt manufacturing flakes) and two contained only a single flake each. All of these sites are large in absolute terms, or large in comparison with the sites that surround them. Even though the sample size is small (see table 2), the data suggest that both celt repairing and particularly celt manufacturing were carried out at only a few important sites.

At the large Sitio Pitti-Gonzalez site, the only one where extensive excavations were undertaken, 363 flakes of celtlike materials were recovered. One hundred of these are classified as celt flakes since they have retained part of the celts' ground and/or polished surfaces. The remaining 263 flakes are possible celt manufacturing flakes. Some of these undoubtedly came from resharpening activities as did the one hundred celt flakes. However, if the ratio of flakes with ground and polished surfaces to flakes without such surfaces produced in experimental celt resharpening is representative (1.0:0.4), only about forty of the Sitio Pitti-Gonzalez possible celt manufacturing flakes can be accounted for by celt resharpening. At least *some* initial celt manufacturing was carried out at the site.

Granting this, it seems unlikely that very much manufacturing was going on at the site. Few of the tools associated with the manufacturing of celts were recovered at the site. Nor were there preforms or celts in any other stage of being manufactured with the single exception of a pecked celt.

TABLE 2 CELT (RESHAPING) FLAKES AND POSSIBLE CELT MANUFACTURING FLAKES FROM WESTERN PANAMA SITES

Site	*Celt flakes*	*Possible celt manufacturing flakes*
Sitio Pitti-Gonzalez (BU-17)	100	263
Barriles (BU-24)	3	6
Fistonich (BU-22)	9	0
BU-15	2	1
BU-16	1	0
BU-33	1	0
BU-39	2	3
BU-49	5	3
BU-55	3	0
BU-65	0	1?
La Pitahaya (IS-3)	191	19
Cerro Brujo (CA-3)	80	31

Moreover, even if *all* of the 263 flakes that were clearly not resharpening flakes are considered to be celt-manufacturing flakes, the number is still quite small. In replicative experiments, an average of 160 flakes (over 1/4 inch) per celt blank (n=5) was produced. Even if tools were being produced for use at this one site only, the number of flakes recovered is off by more than an order of magnitude. Nineteen celts and one chisel were recovered from Sitio Pitti-Gonzalez. To judge from the replicative experiments, somewhere on the order of 3,200 flakes were removed to produce just the tools found at this site. We might recall that the ratio of flakes to core and core tools in the Talamanca deposits was 150 to 1, again suggesting that about 3,000 flakes would have been removed in making the twenty ground and polished stone tools from Sitio Pitti-Gonzalez. Most of the tools involved in establishing the Talamanca phase ratio of flakes to core and core tools were bifacial wedges, which are very similar to celt blanks. Thus the application of this ratio to Sitio Pitti-Gonzalez seem justified. Of course, if specialists at the site were making celts for other settlements, more chipping than 3,000–3,200 flakes would be expected.

Sitio Pitti-Gonzalez is a large site, and only small parts of it were excavated. Thus the possibility exists that within its boundaries a large celt making station will one day be discovered. Nonetheless, I think it more likely that most of the celts used by the Volcan area residents, including those from Sitio Pitti-Gonzalez, were made at large quarry workshop sites outside of the surveyed area. I have visited one such site at India Vieja, midway between the Volcan basin and the Rio Chiriqui canyon, where celt-manufacturing flakes occur thousands upon thousands. There is the possibility that only the preforms were made in quarry workshop sites and that the time-consuming tasks of pecking, grinding, and polishing were carried out at sites like Sitio Pitti-Gonzalez. This possibility however, is not supported by the scarcity of pecking hammers, whetstones, and pebble polishers found at the site.

The interpretation that I feel best accommodates the evidence is that Sitio Pitti-Gonzalez and perhaps another five or six sites in the region served as celt maintenance centers, not manufacturing centers. Celts would originally have been made at quarry workshop sites and imported into the region as finished tools. One or more resident individuals at sites like Pitti-Gonzalez were specialized in repairing damaged and dulled celts, and even occasionally made new ones. The grave of just such a repairman who lived a few centuries earlier than the Bugaba occupation in central Panama has been excavated by Cooke (1978). The tool kit buried with "El Hachero" at Sitio Sierra consisted of 41 basalt polishing pebbles, 1 jasper polishing pebble, 3 heavy basalt hammerstone, 1 basalt pecking hammer, 1 dacite whetstone, 2 small basalt flakes, 2 jasper flakes, a jasper side scraper made on a blade, 8 celts in various stages of reshaping and a basalt cobble fragment flaked along one side (Cooke 1977b).

The manufacture of metates from vesicular basalts and andesites was also a specialized craft. Like celts, they too were probably produced in special quarry workshops and imported by the Volcan settlers. Unlike celts, however, metates and manos are self-sharpening and do not need repair, only replacement. Since we have no specific information on where the source of the stone for metates and manos might be located, and since we have no information from the Volcan sites pertaining to metate manufacturing, it seems prudent not to speculate further. It is interesting, perhaps, to note that the large stone sculptures at Barriles, including the large "ceremonial metates" were made of the same stone as many of the utilitarian metates and manos, and were undoubtedly made "on site." Therefore, craftsmen skilled in working vesicular igneous rocks were available at least at one site in the region.

The move toward specialization in stone tool production and away from any household production continues on both Pacific and Atlantic coasts during the phases that follow the highland Bugaba phase. At the site of La Pitahaya, the ratio of flakes to chipped stone tools is quite low, even during the earliest Burica phase, and gets progressively lower in the succeeding San Lorenzo and Chiriqui phases (table 1). Still, over 800 waste flakes and a number of cores were recovered at the site, as well as 63 tools which were simply used flakes. Thus household production of the very simplest tools appears to continue, albeit on a smaller scale. The small quartz flakes that may have served as insets for graterboards also were made at the site. Bipolar cores of quartz and quartz debitage occur along with the possible grater chips.

Nevertheless, an important part of the chipped stone industry, i.e., the production of blades and trifacial points, was in the hands of specialists. The absence of blade cores and any workshop debris that could be associated with the production of blades or trifaces indicates that these specialists resided elsewhere and that the tools were imported as finished objects.

Similarly, there is no evidence for the manufacture of ground and polished stone tools at La Pitahaya. Fully 191 of 210 flakes of celtlike materials retained the ground and/or polished remnant of the celt. Only 19 are possible celt manufacturing flakes, and they are best interpreted as celt-reshaping flakes as well, in light of the experimental resharpening data discussed earlier. A number of celts showed evidence of reshaping by flaking, pecking, grinding, and polishing. Pecking hammers are also numerous, most being made on broken or exhausted celts. Two whetstones were found at the site, as were a number of pebble polishers (which, of course, could have been used for polishing pots as well as celts). One can easily picture celt repairmen similar to "El Hachero" at Sitio Sierra described by Cooke (1977b) working to return these valuable tools to serviceable condition. The dense igneous rocks employed in making celts do not occur on the island where La Pitahaya is located; thus the need for continual reshaping of old celts is understandable. The recycling of exhausted celts as pecking hammers is also understandable, given the lack of tough dense stone on the island.

Metates and cylindrical (or bar) manos are also made of stone not found on the island and appear to have been imported as finished products. On the other hand, pestles (pounding-mashing stones), nutting stones, notched stones, and grooved stones were made locally of local rock. All these artifacts are easily made and therefore were probably not the handiwork of specialists.

Remarkably little stone manufacturing took place during the Bocas phase occupation of the Aguacate Peninsula (ca. A.D. 900). As mentioned earlier, only four flake tools, twelve waste flakes and five cores can be positively attributed to a household chipping industry. Chipped stone tools are almost entirely made on blades. The absence of blade cores and debitage associated with blade removal clearly indicates that the blades were imported. The ground and polished stone tools from the Aguacate sites were likewise imported as finished implements. Only 21 of 111 flakes of celtlike materials (29 percent) could not be classified as celt flakes. However, since 29 percent of the flakes produced in experimental celt resharpening cannot be classified as celt flakes either, all of the Bocas phase flakes can probably be considered by-products of celt reshaping.

Many of the celts, adzes, and chisels from the Aguacate Peninsula sites show evidence of resharpening by flaking, pecking, grinding, and polishing. Additional indication of celt repair activities is provided by the enormous numbers of pecking hammers found at the sites. As at La Pitahaya, these are made on exhausted or broken celts. Dense, tough stone is no more common on the Aguacate Peninsula than it is at La Pitahaya, and celts have been recycled here in exactly the same manner.

With very few exceptions, all of the stone tools used during the Bocas phase occupations were imported as finished tools. Not only was stone tool production almost entirely a specialized activity, but in addition none of it was carried on at the sites investigated. Cerro Brujo and Sitio Machuca are not large internally differentiated sites like La Pitahaya, Barriles, and Sitio Pitti-Gonzalez. Instead, they are small dispersed hamlets of perhaps a half dozen to a dozen households each. Yet they participated in a regional exchange system as fully as these large centers, since they depended on others for many of the tools needed in obtaining their livelihood.

8.5 SUMMARY AND CONCLUDING REMARKS

From 5000 to 2300 B.C., the production and maintenance of stone tools in western Panama seemed to have been household activities. In fact, until about 300 B.C., they remained household activities with minor exceptions; minor in terms of the number of tools involved. Nonetheless, beginning at around 2300 B.C., ground and polished stone tools requiring both skill and time for their making began to be substituted for chipped stone tools. After 300 B.C., households can no longer be considered self-sufficient since a significant number of the tools they used were produced by craft specialists. Moreover, these specialists were located in only a few places, which meant that celts, axes, metates, and manos had to be imported by most communities. Still, a number of simple chipped stone tools and cobble tools were produced by the households that used them. By A.D. 900, even these simple tools were rarely made or used. They were in the main replaced by tools made on blades by skilled craftsmen. Thus, in some communities like Cerro Brujo, nearly every stone tool used by the residents was imported.

Looking only at the evidence provided by the lithic assemblages, interaction between settlements during the preceramic period can only be characterized as sporadic. Beginning early in the ceramic period, this interaction intensifies to the point where it becomes an essential factor in the functioning of all communities, large and small.

To conclude, I have been concerned with documenting the existence of interaction between communities, pointing out the increasing importance of this interaction through time. I have not attempted to discuss the nature of this interaction, important though it may be, because such a discussion would quickly lead to a consideration of more than lithic assemblages. What, for example, were the commodities given in exchange for celts and metates? What did celt repairmen receive in exchange for their services? Was the exchange reciprocal like the salt for axes system described by Rappaport (1968) for the New Guinea Maring? Or were commodities accumulated and redistributed by a central authority in much the same manner as Flannery (1968b) described for parts of Mesoamerica during the Formative Period? Arriving at answers to these questions is an important goal of archaeological research (cf. Pires-Ferreira and Flannery 1976). Even though this examination of stone tool technology does not provide all the answers, it does provide some (for example, which tools are received in exchange and which are not), which is a step in the right direction.